Learning Activity
Distribution of Climates on the Earth

Developed by
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You'll know you've become a total climate geek when you can imagine how fun it would be if you could get data on monthly precipitation for the last 50 or 100 years from thousands of cities throughout the world! You already have that power in your hands, thanks to the National Ocean and Atmosphere Association's (NOAA) Climate Timeline Tool (http://www.ngdc.noaa.gov/paleo/ctl/) which includes a powerful GIS database.

This assignment will give you a foundation for our discussion of how climate varies spatially over the earth. You'll be able to look at global annual trends, annual trends for specific cities, and how climate varies over the course of a year in a particular place. It will also introduce you to working with this Climate Timeline Database, which might be very useful in your independent final projects. Finally, if you don't already know how, you'll learn how to grab data from the web and get it into MS Excel, and how to make a bar graph. (This activity works also with StarOffice software which is free for educational users.) Students can access specific data for different cities and in class everyone can work together to examine the global patterns of climate processes.

1) Mean annual temperatures and precipitation around the globe

1) Make yourself a map of mean annual precipitation and mean annual temperature.
    - From the http://www.ngdc.noaa.gov/paleo/ctl/ website, choose "Data Access", then the first option on the menu bar "Interactive Climate GIS maps". You'll see a map on your left and some options for what is displayed on the right.
    - When the "Layers" menu is selected, you can modify what is plotted on the map. You can have a number of layers visible. You'll want to subsequently make visible the layers with mean annual temperature and those with mean annual precipitation (but not both at once!). After you change any of the options on what is visible click "refresh" to show them. You might choose to not show (ie uncheck the "visible" box) cities or country boundaries when you display or print the map to make it easier to read. When you have

the map as you'd like to see it you can toggle to the "Legend" menu to see the absolute values. When you are ready to print, select the printer icon from the rightmost toolbars, and scroll so you can see the option to "Create Print Page" which you will select to print.

Write down the major features that you note about the distribution of temperatures and precipitation. What features are as you expect and what aspects are surprising? I encourage you to use a color printer* to print yourself a copy of the map of mean annual precipitation and mean annual temperature.

2) Getting some more specific data on annual climate in cities.

- Make the cities visible under the "layers" option on the right side options bar.
- From the leftmost menu bar, if you select the magnifying glass with the plus sign, you can click anywhere on the map to zoom in (the magnifying glass with the minus sign will let you zoom back out).
- If, on the "layers" option toolbar, you make either "precipitation" or "temperature" the **active** layer (by selecting the active option), you will be able to get the specific annual climate records for any city by selecting the "i" icon from the leftmost menubar and clicking over the city (the data will appear below the map).

To get used to working with this feature, zoom into Spain. I was living for three years in the city of Oviedo, on the northern coast, and have an ongoing research project there on climate records from cave deposits.

a) What are recorded values of precipitation in Oviedo and how do they compare with those from your hometown?

b) Cave temperatures are typically the mean annual temperature. What is the mean annual temperature in Oviedo and would caves there be warmer or cooler than any that might be around your hometown?

3) Looking at how climate varies throughout the year in different places.

From the http://www.ngdc.noaa.gov/paleo/ctl/ website, choose "Data Access", then the second option on the menu bar "Find your place from NGDC". Choose "Geopolitical Regions of the World".

Steps to getting and graphing climate data:

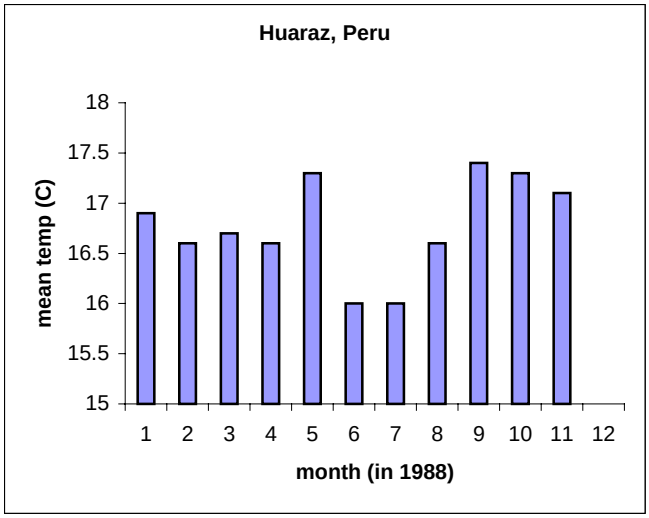
- On the right menu bar choose “GHCN Monthly Precipitation” and click on the region (Complete region list:Complete Country List and state list if you choose) for which you would like to find data.
- When the list of cities come up, find one for which there is some recent climate data (note down its latitude, longitude, and elevation so you can pinpoint it on our map) and click on the name of the station.
- The station data will come up. If you’d like to plot just one year’s worth of data (the simplest), highlight a single line of data, choose copy (Edit:copy or a copy keystroke) and then open an excel sheet, put your cursor on a cell and paste the data in. You might notice some values of “-999.99” which indate no data was collected for that period. You’ll want to choose a year with few of those “-999.99” missing values.
- When you paste into Excel, you’ll notice that the data appears in a single column instead of each month appearing in its own column. No problem, Excel can fix this. Select the cell with the data and go to Data menu and select “Text to Columns”. For this data, there are a few ways to extract it. You can either check off “Fixed width” or you can check off “Delimited” then the Space-delimited option. When you hit finish, each months data (plus the year the data is from) will be in its own cell.
- You’ll find it convenient to type the month (either number or text) above the respective month’s data. The data has been pasted in with each month in its own column, but you might also find it convenient to have months going down in rows. You can do this by selecting the month and precip. Data for the whole year, clicking Edit: copy, and then select an empty cell for a destination and hit Edit: Paste Special: Transpose. (Remember values of “-999.99” indicate that there is no data for that month. Select any cell with that value and go to Edit:Clear:Contents so it doesn’t distort your graph).
- You can graph the data in Excel (or in by pasting the data in your favorite graphing software package) by selecting the precipitation data, the chart wizard key and column graph. You’ll get a series of menus to set the options. In the second window you can select the “Series” tab, go down to the “Category Axis Labels” button, and click the little red arrow to the right of it – this will let you select the range of data with the months – when you’ve selected the range, click the little red arrow again and it will bring you back to the menus, where you can click next and fill in options as you choose.
- You can go back to the very main menu on this website and select “GHCN Temperature” to repeat these steps to make a monthly temperature record.

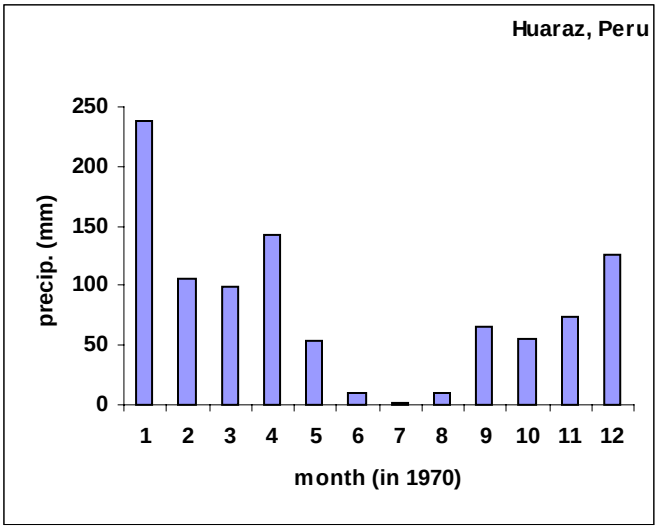
Print a copy of your graphs (on separate page so we can post them) with this assignment.
Note some basic observations (what’s the yearly total rainfall? Is precipitation distributed evenly throughout the year or is there a rainy season? If there is a rainy season, what months are rainy and to what

season they correspond in your region (winter, spring, summer, or fall – remembering that southern hemisphere has opposite seasons). Sample graphs are shown below.

For fun, give us some advice for tourism in the city you selected - if you were going to this city as a tourist, in what month would you go and why?

Grading for this assignment: This assignment will be worth 15 points – 5 points for the written response to each of sections 1-3.





Review questions

1. In your own words, in one paragraph describe what geologists consider to be the “paradox” of the Faint Young Sun. Note why it is challenging to provide a “solution” to a changing sun over the 4.5 billion years of earth history.

2. There are two main solutions to the faint young sun problem. Summarize these two main alternative “solutions”, using the energy balance equation to explain how each affects the earth’s global mean temperature.
3. Describe any important feedbacks in these solutions, for each explaining if it is a negative or positive feedback.
4. What is one weakness to each of the solutions proposed in your answer to #2?